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GB 2134792 A GB 2000452 A GB 1583367 A
GB 1329693 A EP 0243069 A2

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(54) Haemostatic wound dressing material

(57) A wound dressing material comprises a fibrous substrate, such as a needled polyester fleece, having a discontinuous coating of a pharmaceutically acceptable alginate on a surface thereof. The alginate may be selected from calcium, sodium, potassium or ammonium salts. The dressing may be produced by coating a fibrous substrate with an aqueous dispersion of the alginate. Suitable coating methods included knife-over-roll, Meyer rod, screen printing and reverse roll coating.

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At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

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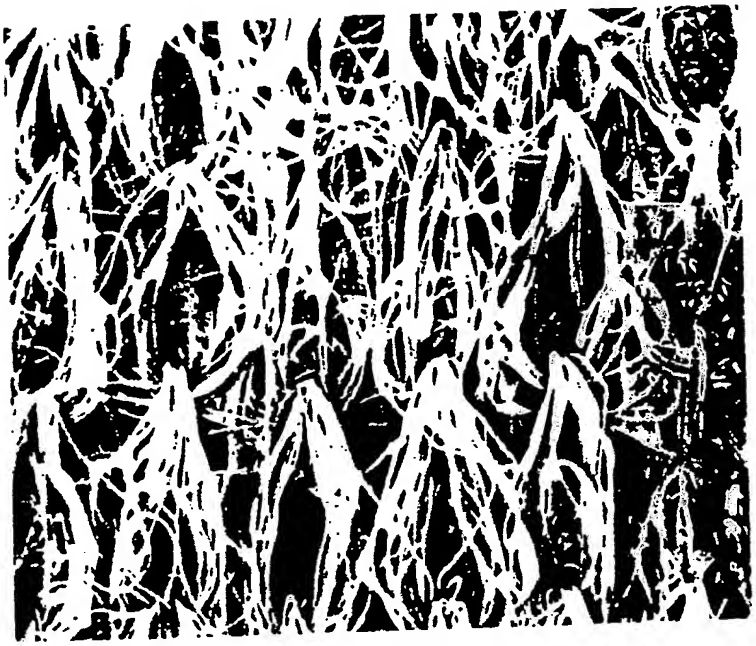

Fig. 1

Fig. 2

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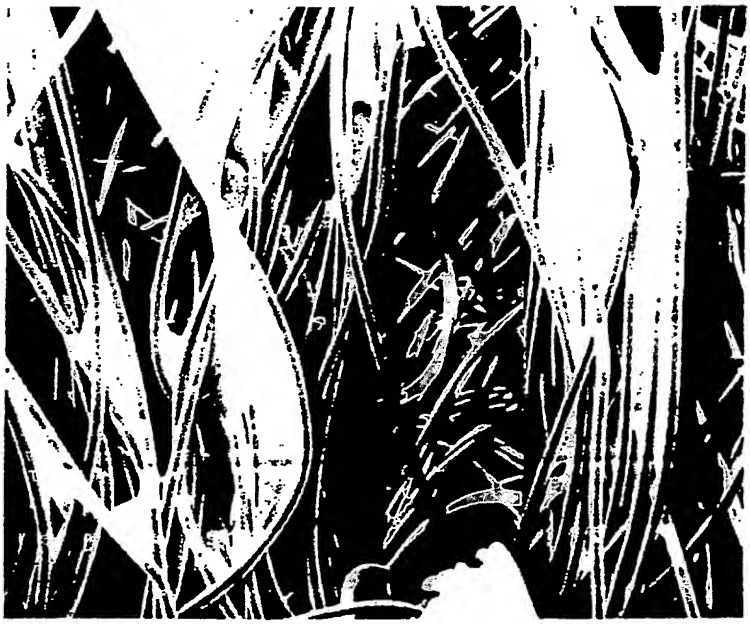

Fig. 3

HAEMOSTATIC WOUND DRESSING MATERIAL

This invention relates to a haemostatic wound dressing material, and more particularly to a fibrous wound dressing material which is coated with an alginate. The invention also provides wound dressings comprising such materials, and methods for their manufacture.

Alginates have long been recognised as useful in wound dressings, because of their haemostatic properties. U.S. Patent Specification No. 2512616 observes that alginates exist in several physical forms, but indicates that fibrous forms are preferred for use in surgical dressings. Alginates woven into a gauze or in the form of loose wool similar to absorbent cotton are particularly identified as being useful.

British Patent Specification No. 629419 discloses a haemostatic surgical dressing which is formed by impregnating a cotton gauze or other fibrous material with relatively large quantities of an insoluble alginate.

British Patent Specification 1329693 also discloses a surgical dressing comprising an alginate as a haemostat. In this case, the alginate is combined with a water-soluble polymer such as polyvinylacetate/polyvinyl-pyrrolidine copolymer, sodium carboxy methyl cellulose, polyethylene oxide, a poly(galactose methacrylate), a poly(galactose acrylate), a copolymer of methyl vinyl ether and maleic anhydride or allantoin polygalacturonic acid. Such a water-soluble polymer is apparently used to allow the alginate to be cast or spread in the form of a film, sheet or block of haemostatic material. This is said to have the advantage that the film, sheet or block slowly dissolves in contact with a wound or burn to release the alginate which is then free to exhibit its haemostatic properties.

British Patent Specification No. 1329693 further discloses

that the alginate/water-soluble polymer mixture may be cast onto a PVC sheet or, in some examples, onto a sheet of Polyweb Net 909 (Smith & Nephew). The latter is a wound-release layer which is widely used in wound dressings.

The dressings proposed in the above-mentioned British Patent specifications do not appear to be commercially available. Currently, alginates are available for use in wound treatment in two principal forms, namely fibrous wads and powder sprays.

The commercially available alginate fibre wads generally use relatively high amounts (typically greater than 100 g/m^2 of wet spun fibres), and are consequently expensive. Further expense is incurred if the wads are needled to increase their integrity.

Alginate powder sprays, such as are described in British Patent Specification No. 1254534, represent a convenient way of administering a haemostat rapidly to the surface of a wound. However, the use of such sprays provides no protection to a wound, and they cannot therefore be regarded as providing an alternative to a conventional wound dressing.

According to the present invention, there is provided a wound dressing material comprising a fibrous substrate having a discontinuous coating of a pharmaceutically acceptable alginate deposited on a surface thereof.

By applying the alginate coating directly to the surface of a fibrous substrate, a very large surface area of alginate in relation to its weight can be achieved. This is of advantage in that, in contrast to the dressings disclosed in British Patent Specification No. 1329693, the alginate rapidly contacts and reacts with any blood from the wound to which the dressing material is applied. Effective haemostasis can therefore be obtained with relatively small

amounts of alginate. The alginate (or alginate formulation) is preferably coated on the substrate at from 1 to 30 g/m^2 dry weight, more preferably at from 5 g/m^2 to 20 g/m^2, and most preferably at from 8 g/m^2 to 12 g/m^2.

Surprisingly, these levels of alginate also provide significant wound-release properties, so that a separate wound-release layer (such as a perforated plastics film or plastics net of the type commonly used in wound dressings) is not required.

Any material suitable for use as a wound-contacting absorbent may be used as the substrate. Materials used as wound-contacting absorbent layers can be woven, knitted or non-woven structures, and may be composed of any suitable fibre. Cotton, rayon, acrylic, polypropylene and polyester fibres are examples of suitable fibre types and may be used alone or in mixtures.

The surface of the fibrous substrate may, if desired, be rendered more amenable to wound-release, for example by hot-calendering the surface fibres, especially with thermofusible fibres. It will be appreciated, of course, that such hot-calendering, if used, should not be to such a degree that the surface of the substrate completely loses its fibrous character.

The preferred fabric for use in the wound dressing material of the present invention is 100% polyester Malifleece within the weight range 100 g/m^2 to 200 g/m^2 (Ledatec Limited). Polyester tends to resist wet-collapse more than rayon, and hence makes a resilient pad which provides a degree of protection by cushioning the wound.

The alginate coating may comprise any pharmaceutically acceptable cationic alginate, such as sodium, calcium, potassium and ammonium alginates or mixtures of these. Sodium and calcium alginates and their mixtures are

preferred.

The haemostatic effect of 100% sodium alginate coatings may be increased by substituting some of the sodium ions by calcium ions. 7.2% calcium, based on the weight of sodium alginate, is required for complete substitution of the sodium ions by the calcium. However, suitable gels are formed with much lower levels of ion exchange, for example from 1 to 3% calcium by weight of alginate, and preferably from 1.5 to 2.5% calcium by weight.

Since it is not desired to form a continuous film of alginate on the substrate, there is no need to include film-forming water-soluble polymers in the alginate coating. Indeed, it is preferred that the alginate coating contain less than 40% by weight of other polymers, and more preferably less than 15% by weight. It is particularly preferred that no more than 5% by weight of other polymers be included in the alginate coatings, because their presence may interfere with the haemostatic effect of the alginate.

In the absence of substantial quantities of a film-forming polymer, alginates tend to be rather friable, and the alginate coating in the wound dressing material of the present invention therefore preferably also contains a plasticiser such as ethylene glycol, propylene glycol or hexylene glycol, or an alkyl citrate or an appropriate mixture. The preferred plasticiser is glycerol (propan-1,2,3-triol). The plasticiser may constitute from 0% to 80% by weight of the coating, and preferably from 10 to 70% by weight. It is particularly preferred that the plasticiser be present in the coating in an amount between 30 and 60% by weight.

The alginate coating may optionally incorporate other additives such as antiseptics, analgesics or other medicaments, preferably in amounts less than 5% by weight, more preferably less than 2% by weight, and most preferably

less than 1% by weight.

Other additives may also be desirable as processing aids. For example, if a sodium/calcium alginate coating is required, a viscous aqueous solution of sodium alginate can be prevented from forming an immediate gel in the presence of calcium ions by the inclusion of pH controlling materials such as glucono lactone or adipic acid/sequestering agent (e.g. sodium citrate). Such materials are typically used in amounts of from 1 to 10% by weight, and preferably from 2.5 to 7.5% by weight. A preservative may also be added to increase resistance to microbial attack of the alginate. Examples of suitable preservatives are Metasol D3T (Merck), Parasept (methyl paraben) (Kaloma Chemical) and Bronopol (2-bromo-2-2-nitropropane-1,3 diol) (Boots Ltd.). Typical ranges for the amount of preservative are from 0.1% to 5.0% by weight, and preferably from 0.25 to 1.0% by weight.

When an alginate coating is applied to a fibrous substrate in accordance with the invention, the individual fibres which lie close to the surface of the substrate are at least partly coated. Also, extremely thin films of alginate may be formed between adjacent fibres near points of crossover. A discrete film or layer of alginate on the surface of the substrate is avoided, so that the permeability of the substrate to gases (such as air and water vapour) is not lost. Coating techniques which are suitable for achieving such a distribution include knife-over-roll, Meyer rod, screen printing and reverse roll coating. Reverse roll coating is particularly suitable, because it allows controlled amounts of material to be applied to a given area of substrate, even with substrates having variable and uneven surfaces.

The alginate is preferably applied to the substrate as a viscous aqueous, or substantially aqueous, fluid. The viscosity of the aqueous suspension of the alginate composition may be adjusted to suit the coating technique

employed, but for reverse roll coating viscosities in the range 2000 cp to 30,000 cp, and preferably from 3000 cp to 8000 cp are appropriate. Control of the nip-gap and of the casting ratio determines the amount of coating material applied to the substrate, as is well known in the coating art.

For reverse roll coating, the nip gap between the doctor roll and the applicator roll is typically from 0.075 to 0.45 mm, and preferably from 0.10 to 0.30 mm, e.g. from 0.15 to 0.20 mm.

The casting ratio (i.e. the ratio of the applicator roll peripheral speed to the backing roll peripheral speed) is generally in the range 0.8:1 to 1.7:1, and more preferably in the range 1:1 to 1.5:1, e.g. 1.2:1

Evaporation of the water phase may be achieved by any suitable means, for example by passage through temperature-controlled ovens. The oven is suitably at a temperature of from 100 to 150°C, e.g. from 110 to 140°C. If desired, a gradually increasing oven temperature may be employed. Drying will typically take from 1 to 10 minutes, and more usually from 2 to 5 minutes.

The alginate-coated wound dressing material of the invention preferably has a gas permeability (as defined herein) which is at least 50% of the gas permeability of the material prior to coating with alginate. More preferably, the gas permeability of the coated material is from 60% to 98% of the permeability of the uncoated material, and most preferably from 75% to 95%, eg. from 85% to 92.5%.

The term "gas permeability" refers to the permeability of a wound dressing material to cyclohexane vapour, which (unlike water vapour) is inert to the alginate and will not cause the alginate to swell. The test method is as follows:

10 ml of cyclohexane is placed in a 4 cm diameter cylindrical test cell, which is then closed using a layer of the test material. The cell is placed in a fume cupboard at 25° and the rate of loss of cyclohexane vapour is measured by weighing the cell periodically (eg. hourly for 5 hrs). Permeability may conveniently be expressed in terms of grams of cyclohexane lost/m^2/24 hrs.

Typically, the wound dressing materials of the present invention have a gas permeability of from 2500 to 20000 g/m^2/24 hrs, and more preferably from 4000 to 15000 g/m^2/24 hrs. Particularly preferred are dressing materials having a gas permeability of from 5000 to 10000 g/m^2/24 hrs.

The wound dressing materials of the present invention are suitable for use in a variety of forms. For example, they may be used either alone (being secured in place by bandaging, adhesive tape, or any other suitable means), or they may be formed into composite dressings. Indeed, the material of the present invention can advantageously be used in any of the circumstances in which absorbent wound dressing pads are conventionally used. They are particularly suitable for use as post-operative dressings.

Composite dressings including the dressing material of the present invention will generally comprise a fibrous pad having an alginate coating on one surface, and a backing material secured to the opposed surface. The backing material may be porous or non-porous, but materials which are impermeable to water but permeable to water vapour are particularly preferred. Such materials include, for example, cast polyurethane films. Alternatively, the backing material may be a perforated plastics film, such as those conventionally used in first-aid dressings.

Wound dressings comprising the wound dressing material of the present invention will generally be supplied in sterile form, contained in a bacteria-proof envelope. Such

envelopes may be of any conventional form, such as a pouch formed from two superimposed layers of plastics film, heat-sealed around their periphery.

Sterilisation may be achieved by any conventional means, such as by autoclaving, gamma-irradiation and ethylene oxide treatment.

The invention is further described by reference to the following example.

EXAMPLE 1

An alginate composition having the following formulation was prepared by simple mixing of the listed components:

	%w/w
Sodium alginate	1.96
Calcium orthophosphate	0.17
Glucono lactone	0.17
Glycerol	1.34
Bronopol	0.02
Water	96.34

The ratio of calcium ions to sodium ions in this formulation is 46.6/53.4.

The composition was reverse roll coated onto the surface of Malifleece P/175/15 fabric, which is a 100% polyester fabric of weight 175 g/m^2. The coating conditions were chosen to produce a coating weight of 273 g/m^2, which after drying in an oven at a temperature increasing from 110°C to 130°C for 5 minutes, yielded a dry coating weight of 10 g/m^2.

Scanning electron microscopy showed the alginate coating to form extremely thin films between individual fibres, with very little effect on the overall porosity of the fabric. This can clearly be seen from Figures 1, 2 and 3, which are micrographs at magnifications of 13X, 31X and 67X,

respectively.

The coated material was found to be highly effective as a wound dressing. Not only was the small amount of alginate found to give effective haemostasis, but it also significantly improved release of the dressing from the wound, as compared with uncoated Malifleece fabric.

EXAMPLE 2

The composition described in Example 1 above was applied to two samples of 150 g/m^2 polyester Malifleece fabric at a rate of 10 g/m^2. In the first case, the alginate was applied to the smooth surface of the fabric, while in the second case the alginate was applied to the opposite, less dense, surface. The gas permeability of the two samples and of the uncoated Malifleece fabric was measured using the test described above. The results were as follows:

Sample	Gas Permeability
uncoated fabric	10,400 g/m^2/24 hr
fabric coated on smooth surface	7600 g/m^2/24 hr
fabric coated on less dense surface	7800 g/m^2/24 hr

EXAMPLE 3

Example 2 above was repeated, using a knitted hydrophobic polyester fabric. The coating conditions were selected to achieve a coating rate of 30 g/m^2 on the smooth surface, but the same coating conditions gave a coating rate of 25 g/m^2 when applied to the raised surface. It is thought that the different structure of the raised surface simply results in a lower pick-up of the alginate solution from the applicator roll.

Sample	Gas Permeability
uncoated fabric	9800 g/m^2/24 hr
fabric coated on smooth surface	5400 g/m^2/24 hr
fabric coated on raised surface	4900 g/m^2/24 hr

This example illustrates that a coating weight as high as 30 g/m^2 can be applied to a knitted hydrophobic polyester fabric while retaining 50% of the gas permeability of the fabric.

It will be understood that the present invention has been described above purely by way of example, and many variations will be possible within the scope of the invention.

CLAIMS

1. A wound dressing material comprising a fibrous substrate having a discontinuous coating of a pharmaceutically acceptable alginate on a surface thereof.

2. A wound dressing material according to claim 1, wherein the alginate is selected from calcium, sodium, potassium and ammonium alginates and mixtures thereof.

3. A wound dressing material according to claim 1 or claim 2, wherein the alginate is present on the surface of the substrate in an amount of from 5 g/m^2 to 20g/m^2.

4. A wound dressing material according to any preceding claim wherein the coating additionally comprises from 10 to 70% by weight of plasticiser.

5. A wound dressing material according to any preceding claim wherein the coating additionally comprises an antiseptic, an analgesic or a pH controlling agent.

6. A wound dressing material according to any preceding claim wherein the coating comprises a mixture of sodium and calcium alginates, having a ratio of calcium ions to sodium ions of from 20:80 to 80:20.

7. A wound dressing material according to any preceding claim wherein the substrate is a woven, knitted or non-woven fabric.

8. A wound dressing material according to any preceding claim wherein the substrate comprises cotton, rayon, acrylic, polypropylene or polyester fibres or a mixture thereof.

9. A wound dressing comprising a wound dressing material according to any preceding claim.

10. A method of making a wound dressing material according to any of claims 1 to 8, comprising coating a fibrous substrate with an aqueous dispersion of a pharmaceutically acceptable alginate, and subsequently drying the coated substrate.

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